

CLAIMS

What is claimed is:

- 1           1. An apparatus comprising:
  - 2           a base adapted to be secured to a window;
  - 3           a inner rotatable hollow wedge-cut member having a base end
  - 4       defining a inner base plane, operatively coupled to the base so as to
  - 5       enable rotation of the inner rotatable hollow wedge-cut member about the
  - 6       base, and having a top end defining a top plane that forms an acute angle
  - 7       with the base plane;
  - 8           a outer rotatable hollow wedge-cut member having a base end
  - 9       defining a outer base plane, operative coupled to the top end of the inner
  - 10      rotatable hollow wedge-cut member so as to enable rotation of the outer
  - 11      rotatable hollow wedge-cut member about the top end of the inner
  - 12      rotatable hollow wedge-cut member; and
  - 13      a support coupled to the outer rotatable hollow wedge-cut member,
  - 14      providing a mounting interface for an optical device such that when the
  - 15      optical device is mounted to the mounting interface an optical axis of the
  - 16      optical device is not perpendicular to the outer base plane,
  - 17      wherein the optical axis of the optical device can be directed
  - 18      through the window along any angle within a cone of angulation by
  - 19      rotating the inner and outer rotatable hollow wedge-cut members to
  - 20      appropriate positions.

1           2. The apparatus of claim 1, further comprising:  
2           a cover, mounted to the a top end of the outer rotatable hollow  
3 wedge-cut member;  
4           a first sealing means for creating an air-tight seal between the base  
5 and the inner rotatable hollow wedge-cut member; and  
6           a second sealing means for creating an air-tight seal between the  
7 inner rotatable hollow wedge-cut member and the outer rotatable hollow  
8 wedge-cut member,  
9           wherein the window, base, inner and outer rotatable hollow edge-  
10 cut members and the cover form a sealed volume so as to enable the  
11 apparatus to be secured to the window by applying a vacuum to the  
12 sealed volume.

1           3. The apparatus of claim 2, wherein the cover further includes an  
2 air-tight optical aperture through which light can be pass, thereby enabling  
3 the optical device to be mounted outside of the sealed volume and  
4 receive and/or transmit light through the clear air-tight aperture.

1           4. The apparatus of claim 2, further comprising a gasket disposed  
2 between the base and the window.

1           5. The apparatus of claim 2, wherein the base end of the inner  
2 rotatable hollow wedge-cut member comprises a first annular flange and  
3 the inner sealing means comprises a first sealing ring disposed between  
4 the inner first flange and the base, and the top end of the inner rotatable  
5 hollow wedge-cut member and the base end of the outer rotatable hollow  
6 wedge-cut member respectively comprise second and third annular  
7 flanges, and the outer sealing means comprises a second sealing ring  
8 disposed between said outer and third annular flanges.

1           6. The apparatus of claim 5, wherein application of a vacuum to  
2 the sealed volume enables the base end of the inner rotatable hollow  
3 wedge-cut member to be operatively coupled to the base and the base  
4 end of the outer rotatable hollow wedge-cut member to be operatively  
5 coupled to the top end of the inner rotatable hollow wedge-cut member by  
6 causing a pressure differential between an atmospheric pressure  
7 condition on the outside of the sealed volume, and the vacuum on the  
8 inside of the sealed volume, said pressure differential applying a first force  
9 between the inner annular flange and the base acting upon the first  
10 sealing ring and a second force between the second and third annular  
11 flanges acting on the second sealing ring.

1           7. The apparatus of claim 5, further comprising a lubricant  
2 disposed between the first sealing ring and the first annular flange and the

3 base and between the second sealing ring and the second and third  
4 annular flanges.

1 8. The apparatus of claim 2, further comprising:  
2 a vacuum line having an input coupled to one of the components  
3 comprising the sealed volume and an output; and  
4 a check valve inline with the vacuum line that enables air to be  
5 expelled from the sealed volume when a vacuum is applied to the output  
6 of the vacuum line but prevents air from passing into the sealed volume  
7 when the output of the vacuum line is exposed to an atmospheric  
8 condition.

1 9. The apparatus of claim 2, further comprising a low-volume  
2 piezoelectric vacuum pump having an input operatively coupled to the  
3 sealed volume and an output exhausted to the atmosphere.

1 10. The apparatus of claim 1, wherein the base includes an inner  
2 annular flange and the base end of the inner rotatable hollow wedge-cut  
3 member comprises a outer annular flange, one of said inner and outer  
4 annular flanges having an overlapping tang that interlocks with the other  
5 annular flange, and the top end of the inner rotatable hollow wedge-cut  
6 member and the base end of the outer rotatable hollow wedge-cut  
7 member respectively comprise third and fourth annular flanges, one of

8 said third and fourth annular flanges having an overlapping tang that  
9 interlocks with the other annular flange.

1 11. The apparatus of claim 1, further comprising:

2 a first mechanical positioning means coupled between the base  
3 and the inner rotatable hollow wedge-cut member for rotating the inner  
4 rotatable hollow wedge-cut member relative to the base; and

5 a second mechanical positioning means coupled between the inner  
6 rotatable hollow wedge-cut member and the outer rotatable hollow wedge-  
7 cut member for rotating the inner rotatable hollow wedge-cut member  
8 relative to the outer rotatable hollow wedge-cut member.

1 12. The apparatus of claim 11, wherein the first mechanical  
2 positioning means comprises a first gear box mounted to the base and a  
3 first ring gear coupled to the inner rotatable hollow wedge-cut member,  
4 and wherein the second mechanical positioning means comprises a  
5 second gear box mounted to the inner rotatable hollow wedge-cut  
6 member and a second ring gear coupled to the outer rotatable hollow  
7 wedge-cut member.

1 13. The apparatus of claim 1, wherein the optical device comprises  
2 a Cassegrain collector comprising:

3 a primary reflector operatively coupled to the outer rotatable hollow  
4 wedge-cut member; and  
5 a secondary reflector operatively coupled to the primary reflector.

1 14. The apparatus of claim 13, wherein the primary reflector  
2 includes a central aperture through which light may pass through, further  
3 comprising a lens disposed within a central portion of the secondary  
4 reflector having an optical axis in alignment with an axis extending through  
5 the central aperture of the primary reflector.

1 15. A free space optical communications system comprising:  
2 a first optical transceiver mounted to a window in a first building;  
3 a second optical transceiver mounted to a window in a second  
4 building, each of said first and second optical transceivers comprising:  
5 a set of transceiver optics and electronics for transmitting  
6 and receiving an optical signal; and  
7 a multi-axis positioning mechanism mounted to the window  
8 and coupled to the set of transceiver optics and electronics for  
9 controlling an orientation of the set of transceiver optics and  
10 electronics such that outgoing optical signals emitting from each  
11 transceiver are directed toward the other transceiver so as to  
12 enable bi-directional communication between the first and second  
13 optical transceivers.

1           16. The free space optical communications system of claim 15,  
2 wherein each of the multi-axis positioning mechanisms comprise:  
3           a base mounted to the window;  
4           an inner rotatable hollow wedge-cut member having a base end  
5 defining a inner base plane, operatively coupled to the base so as to  
6 enable rotation of the inner rotatable hollow wedge-cut member about the  
7 base, and having a top end defining a top plane that forms an acute angle  
8 with the base plane;  
9           an outer rotatable hollow wedge-cut member having a base end  
10 defining a outer base plane, operative coupled to the top end of the inner  
11 rotatable hollow wedge-cut member so as to enable rotation of the outer  
12 rotatable hollow wedge-cut member about the top end of the inner  
13 rotatable hollow wedge-cut member; and  
14           a support coupled to the outer rotatable hollow wedge-cut member,  
15 providing a mounting interface for an optical device corresponding to the  
16 transceiver optics and such that when the optical device is mounted to the  
17 mounting interface an optical axis of the optical device is not  
18 perpendicular to the outer base plane;  
19           wherein the optical axis of the optical device can be directed  
20 through the window along any angle within a cone of angulation by  
21 rotating the inner and outer rotatable hollow wedge-cut members to  
22 appropriate positions.

1           17. The free space optical communications system of claim 15,  
2 wherein the transceiver optics include a Cassegrain collector comprising a  
3 primary reflector that receives an incoming light signal and reflects the  
4 light signal toward a secondary reflector that in turn reflects the light  
5 toward a light detecting component.

1           18. The free space optical communications system of claim 15,  
2 wherein the set of transceiver optics and electronics comprises a  
3 magnetic fluid based fiber optic positioning apparatus that controls a  
4 position and orientation of an end portion of a fiber optic cable from which  
5 optical signals are emitted by controlling a magnetic field acting on a  
6 magnetic fluid in which the end portion of the fiber optic cable is disposed.

1           19. The free space optical communications system of claim 15,  
2 wherein each of the first and second transceivers is mounted to a  
3 respective window using a vacuum.

1           20. The free space optical communications system of claim 19,  
2 wherein the vacuum that is used to mount each of the first and second  
3 transceivers to their respective windows is maintained by a low-volume  
4 piezoelectric vacuum pump.